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CENTRAL INTELLIGENCE AGENCY
WASHINGTON 25, D. C.

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11 JUL 1962

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : "Combat with Enemy Nuclear Artillery, Free Rockets, and Guided Missiles in Offensive and Defensive Operations of an Army" (Chapter IV)

1. Enclosed is a verbatim translation of Chapter IV of an eight-chapter TOP SECRET Soviet publication entitled "Combat with Enemy Nuclear Artillery, Free Rockets, and Guided Missiles in Offensive and Defensive Operations of an Army". It was issued by Scientific-Research Artillery Institute No. 1 in Leningrad in October 1960.

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Downgraded to Secret by Authority of Richard Helms, DD/P, per memo dated 14 Dec. 1962

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Richard Helms

Richard Helms
Deputy Director (Plans)

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Original: The Director of Central Intelligence

cc: The Director of Intelligence and Research, Department of State

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The Director for Intelligence, The Joint Staff

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COUNTRY : USSR

SUBJECT : Combat with Enemy Nuclear Artillery, Free Rockets, and Guided Missiles in Offensive and Defensive Operations of an Army (Chapter IV)

DATE OF INFO : October 1960

APPRAISAL OF CONTENT : Documentary

SOURCE : A reliable source (B).

Following is a verbatim translation of Chapter IV of a TOP SECRET Soviet publication titled "Combat with Enemy Nuclear Artillery, Free Rockets, and Guided Missiles in Offensive and Defensive Operations of an Army". This document contains eight chapters and was published on 15 October 1960 by Scientific-Research Artillery Institute No. 1 in Leningrad. Each chapter will be disseminated as it becomes available and is translated.

In some cases, there are imperfections in the original text which leave doubt as to the accuracy of translation. Question marks are inserted in brackets following uncertain words or phrases. As in other IRONBARK reports, transliterated Cyrillic letters are underlined in translation, while Greek and Roman letters are given as in the original.

According to source, the 3R10 is a free rocket, since it starts with the figure "3", and the 8K11 is a guided ballistic missile, since it begins with the figure "8", The latter missile is cited in [redacted] (b)(3)

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Chapter IV

The Destruction of Enemy Offensive Nuclear Weapons by Tactical and Operational-Tactical Missiles

1. Nature of targets and their vulnerability to a nuclear burst

To destroy enemy offensive nuclear weapons, tactical and operational-tactical missiles (raketa) with nuclear warheads are used. Investigation has shown that the use of conventional warheads for these targets is inadvisable. The primary targets (objectives) among the enemy offensive nuclear weapons which are to be destroyed by tactical missiles are: launchers with "Lacrosse", "Honest John", and "Little John" missiles/rockets at firing positions and waiting positions (vyzhidatelnaya pozitsiya), on the march, and in the concentration area, and 280mm (203.2mm) guns at firing positions and waiting positions, on the move, and in the concentration area; technical positions and nuclear ammunition depots of subunits equipped with "Lacrosse" guided missiles, "Honest John" and "Little John" free rockets and 280mm (203.2mm) guns; and transports with nuclear ammunition for these subunits. The main targets for destruction by operational-tactical missiles are: "Corporal", "Sergeant", and "Redstone" guided missiles at launch sites, on the march, and in concentration areas; "Matador" and "Mace" cruise missiles at launch sites; "Nike-Hercules" antiaircraft guided missiles at launch sites; technical positions and nuclear warhead depots for subunits equipped with "Corporal", "Sergeant", and "Redstone" guided missiles, "Matador" and "Mace" cruise missiles or "Nike-Hercules" antiaircraft guided missiles; transports with nuclear warheads for these subunits; and army ammunition supply points.

For convenience in estimating the effectiveness of fire, the above-named enemy offensive nuclear weapons can be divided into two groups of targets: individual and group targets.

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Individual targets are those whose size is negligible compared with the size of the destruction zone of a nuclear burst, for example: individual launchers (guns) at firing positions (launch sites), waiting positions, and on the march; batteries of 203.2mm guns; technical positions of subunits; transports with nuclear warheads; subunits' depots of nuclear warheads; guidance posts (punkt navedeniya) for guided missiles, etc. The location of an individual target will be given as coordinates, without any indication of size.

Group targets include: enemy subunits (units) equipped with guided missiles, free rockets, and also 280mm and 203.2mm guns in waiting and concentration areas; army ammunition supply points; a group of individual targets which it is intended to destroy with one nuclear warhead when the location of the individual targets is known exactly; the expected area of deployment of individual guided missiles (free rockets, guns) when their exact location is not known; other targets representing, as a rule, several individual targets located in a certain area /?/ (at a certain distance from each other) commensurate with the destruction zone of a nuclear burst. The position of the individual targets within the limits of the area may be known or not known, and the nature of the individual targets may be different.

The location and the size of a group target are defined either by the coordinates of the center of the area, showing the radius of a circle whose circumference (R_{ts}) contains the area of the group target (when the location of the individual targets is not known), or by the coordinates of each individual target when their location is known exactly.

A detailed description of the various offensive nuclear weapons of the probable enemy is given in Chapter I. An analysis of these data leads to the following conclusions.

By their nature, individual targets are combined targets, consisting of elements of different vulnerability

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(the materiel part of the launcher or the gun, the missile, personnel, radar stations, motor transport, etc.). The destruction of some of these elements, which we shall call the main elements, disables the whole target and consequently puts it out of action (destroys it). For example, to disable a guided missile like the "Lacrosse" at the firing position, it is essential either to put out of action all the personnel (crew) employed on the launcher, or to damage the launcher or the missile.

On the other hand, out of the several main vulnerable elements of each target it is possible to select the most vulnerable, the destruction of which will require the nuclear charge with the smallest /?/ yield. For our /?/ example the most vulnerable element will be the personnel (crew).

Group targets, as a rule, consist of several individual targets of unequal vulnerability. The destruction of some individual targets, which we shall call main /?/ leads to putting the whole group target out of action.

For example, for a battalion of "Corporal" guided missiles deployed in battle formation the main individual targets are the two launchers with missiles, the crews, and the guidance post.

By analogy with the preceding, it is possible in many cases to distinguish out of the several individual main targets the most vulnerable, i.e., the one the destruction of which will require the nuclear warhead with the smallest yield. In the example given above, the most vulnerable main individual target will be the guidance post. It will be noted that in the given instance the destruction of the group target can be achieved by the destruction of one individual target. If the location of the guidance post is not known, the next most vulnerable individual targets will be the crews of the two launchers.

Tables 21 and 22, compiled on the basis of the analysis of data in Chapter 1, list the enemy offensive nuclear weapons, representing individual and group targets, showing

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the main and the most vulnerable elements of each individual target and also the most vulnerable individual targets in each group target. Moreover, the tables show, in addition, the nature of elements (targets), and their equivalents in vulnerability, for which radii of destruction zones are given in the handbooks /?/.

Table 21

Basic and Most Vulnerable Elements of Individual Targets

Serial	Description of target	Basic elements of target	Most vulnerable elements	Nature of target with equivalent Rp (from handbook)
1	2	3	4	5
1	"Lacrosse" guided missile, "Honest John", "Little John" free rockets at firing position	Launcher /?/ with missile/rocket deployed in the open /?/	Personnel in the open	Personnel in the open
2	"Lacrosse" guided missile, "Honest John" "Little John" free rockets in the waiting area	Launcher with missile/rocket in pit, personnel in shelters	Launcher with missile/rocket in pit	Free rocket of "Honest John" type
3	"Lacrosse" guided missile, "Honest John" "Little John" free rockets on the march (when changing position)	Launcher with missile/rocket in the open	Launcher with missile/rocket in the open	Free rocket of the "Honest John" type
4	Transport with "Lacrosse" missile, "Honest John", "Little John" rockets	Missile/rocket on carrier	Missile/rocket out in the open	Free rocket of the "Honest John" type

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Table 21 continued

Serial	Description of target	Basic elements of target	Most vulnerable elements	Nature of target with equivalent R_p (from handbook)
1	2	3	4	5
5	280mm gun at firing position	Gun in the open, personnel in the open	Personnel in the open	Personnel in the open
6	280mm gun in the waiting area	Gun in pit, personnel in shelter	Gun in pit	Gun NA (nazemnaya artilleriya - field artillery)
7	280mm gun on the march	Gun and prime movers in the open	Gun in the open	Gun NA
8	Batteryof 203.2mm guns in firing position	Guns in pits, personnel in pits and shelters	Guns in pits	Guns NA
9	Ammunition depots of "Lacrosse" guided missile and "Honest John" and "Little John" free rocket subunits	Missile/rocket in shallow pit (kotlovan)	Missile/rocket in shallow pit	Free rocket of the "Honest John" type
10	"Corporal," "Sergeant," and "Redstone" guided missiles at launch site	Launcher with missile in the open; personnel in the open	Personnel in the open.	Personnel in the open
11	"Corporal", "Sergeant", and "Redstone" guided missiles on the march. Transport with "Corporal", "Sergeant" and "Redstone" missiles	Missile on launcher (on carrier).	Missile in the open	Guided missile of the "Corporal" type

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Table 21 continued

Serial	Description of target	Basic elements of target	Most vulnerable elements	Nature of target with equivalent R_p (from handbook)
1	2	3	4	5
12	Ammunition depots of subunits equipped with "Corporal", "Sergeant", and "Redstone" guided missiles	Missile in shallow pit	Missile in shallow pit	Guided missile of the "Corporal" type
13	Technical position of subunits equipped with the "Lacrosse" guided missile, "Honest John", "Little John" free rockets, 280mm guns, "Corporal", "Sergeant" and "Redstone" guided missiles and the "Nike-Hercules" antiaircraft guided missile	Equipment on special vehicles deployed in the open, launchers with missiles in the open	Equipment on special vehicles	Trucks (gruzovoy avtomobil)
14	"Matador" and "Mace" cruise missiles on launching pad	Missile deployed in the open, personnel deployed in the open	Missile deployed in the open	"Matador" cruise missile
15	Guidance post for guided missile. /one word missing/ radar control of cruise missile. Control post of fire battery of "Nike-Hercules" antiaircraft guided missile	Radio-technical equipment	Radio-technical equipment	Radar station of the SON-4 type

Table 22

The Most Vulnerable Elements (Individual Targets) of Group Targets

Serial	Description of targets	The most vulnerable targets (elements)	The distance between the two most widely separated individual targets (area of target)	Nature of target with equivalent R_p (from handbook).
1	2	3	4	5
1	Battery (battalion) of "Lacrosse" guided missiles at firing position	Four launchers with missiles at firing positions	1 km^2 and more	Personnel deployed in the open
2	Battery of "Honest John" ("Little John") free rockets at firing position	Two launchers with rockets at firing positions	200 to 400m	Personnel deployed in the open
3	Battalion of "Honest John" free rockets in the siting area (pozitsionnyy rayon)	Four launchers with rockets in firing positions	900 to 1800m	Personnel deployed in the open
4	Battery of 280mm guns at firing position	Two guns at firing position	800 to 1000m	Personnel deployed in the open
5	Battalion of 280mm guns in siting area	Six guns in firing positions	2000to 8000m	Personnel deployed in the open

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Table 22 continued

Serial	Description of targets	The most vulnerable targets (elements)	The distance between the two most widely separated individual targets (area of target)	Nature of target with equivalent R_p (from handbook)
1	2	3	4	5
6	Battalion of 203.2mm guns in siting area	Three batteries in firing positions	1500 to 4000m	Guns NA
7	Battalion of 203.2mm guns in concentration area	Gun equipment	3/?/ to 6km^2	Guns NA
[illegible]	Battalion of 280mm guns in concentration area (waiting area)	Gun equipment	3 to 6km^2	Guns NA
9	Battalion of "Honest John" free rockets, ("Lacrosse" guided missile) in concentration area	Launcher equipment	6/8?/to 10km^2	"Honest John" free rocket
10	Battalion of "Corporal" ("Sergeant") guided missiles in siting area	Guidance post. Two missiles at launch sites *	700/?/ to 2800m	Radar station type SON-4 and personnel deployed in the open

* When the location of the guidance post (controlling radar) is not known /?/.

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Table 22 continued

Serial	Description of targets	The most vulnerable targets (elements)	The distance between the two most widely separated individual targets (area of target)	Nature of target with equivalent R_p (from handbook)
1	2	3	4	5
11	Battalion of "Corporal" and "Sergeant" guided missiles in concentration area	Missile equipment	7.5 to 12km^2	"Corporal" guided missile
12	Battle group of "Redstone" guided missile in siting area	Two missiles at launch sites	1500/?/ to 2000m	Personnel deployed in the open
13	Detachment /?/ of "Matador" and "Mace" cruise missiles in the siting area	Controlling radar station; two cruise missiles on launch pad *	300 to 500	Radar station type SON-4, "Matador" cruise missile
14	Army ammunition supply point	Personnel	4km^2	Personnel deployed in the open
15	Battery of "Nike-Hercules" antiaircraft guided missile at launch site	Launcher equipment	1200m	"Honest John" free rocket

*When the position (the controlling radar) is not known.

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Evaluation of the action of a nuclear burst shows that for the destruction of the overwhelming majority of the targets listed in Tables 21 and 22, it is best to employ air bursts. The various kinds of shallow pits, pits, and other installations for shelter of crews /?/ in view of their large size /?/, do not actually ensure protection from air bursts (17). The radii of the destruction zones of these targets from nuclear air bursts are shown in Figure 9. With nuclear ground /?/ bursts, the radii of the destruction zones as shown in Figure 9 should be correspondingly reduced:

by 10 to 20 percent for personnel deployed in the open,

by 10 percent /?/ for SON-4,

by 10 percent for "Matador" cruise missiles and for trucks,

by 15 percent /?/ for "Corporal" guided missiles,

by 10 percent for "Honest John" free rockets,

by 5/?/ percent for field artillery guns.

For personnel located in a shelter the radius of the destruction zone, as shown in Figure 9, should be reduced by 8 percent.

2. Task of firing for destruction (porazheniye)

The evaluation of the destructive action of a nuclear burst leads to the conclusion that missiles with nuclear charges may inflict decisive damage on an individual target, as well as on a group of individual targets deployed at a considerable distance from each other, and thus put out of action whole subunits (units). The considerable destructive capabilities of missiles with nuclear charges also permit their being used to destroy enemy offensive nuclear weapons, the location of which is determined only approximately, and this is particularly important if the difficulties of aerial reconnaissance in an area with strong antiair defense (PVO) are considered.

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Firing with tactical and operational-tactical missiles against such targets as enemy offensive nuclear weapons is usually delivered with the object of destroying them. Here their destruction must be achieved with one nuclear warhead with the necessary yield.

As an indication of the effectiveness of firing for destruction (porazheniye), the probability of the annihilation (unichtozheniye) of the target is used. Taking into consideration the importance of the targets and also the circumstance that, as a rule, one nuclear warhead is expended against the target, the degree of probability that the target will be destroyed must be high. It is usual to consider that to meet this requirement the probability must be 80 to 90 percent or higher.

The destruction of a target consists of the infliction on it of such damage (losses) that as a result it will be put out of action completely, or will lose its combat effectiveness for the duration of the engagement (operation).

We shall reckon that the destruction (unichtozheniye) of an individual target is achieved as a result of destroying (porazheniye), with a probability of no less than 90 percent, of at least one, as a rule the most vulnerable, of the vulnerable main elements of the target. The destruction of a group target is achieved by the destruction of each main individual target of those comprising the given group target.

3. Determination of the required yield of nuclear charge Q to destroy (unichtozheniye) an individual and a group target. Determination of probability P of destroying (porazheniye) the target by a charge of a given yield. Yields of nuclear charges to destroy (unichtozheniye) various targets.

The essence of evaluating the effectiveness of fire with nuclear warheads against various targets is to determine the

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yield of the nuclear charge Q necessary to destroy the target, and also to determine the probability P of destruction of the target by a nuclear charge of a given yield.

It should be noted that these problems have now been studied in comparative detail. The practical methods which have been developed for determining Q and P have been assimilated by the troops and tried out in a number of exercises, and on the whole they meet operational requirements. The troops and the training establishments have made several suggestions to improve the efficiency of existing methods.

The study of these problems in this work is mainly concerned with further refinement/ of determining Q and P under conditions when the ground zero of a nuclear burst (point of aim) must be projected to a certain distance from the target, i.e., under conditions of aiming-off (vynos tochki pritselivaniya).

A number of authors of articles in military journals mention aiming-off, as a rule, only in connection with ensuring the safe distance of friendly troops; other cases requiring aiming-off are omitted, thereby giving a wrong impression of the importance of the problem of aiming-off.

Aiming-off is most widely used during destruction of enemy offensive nuclear weapons when a nuclear strike is delivered with the object of destroying several isolated targets.

The most widely used practical method of determining Q and P when firing on an individual target is by using graph $R_p = f(P, \underline{E}, \underline{V}_p)$, showing the ratio between probability of destruction of target P, radius of the destruction zone R_p, nuclear charge Q, and the elliptical error of the shot, which is defined by the relation E * of the minor axis of a single ellipse of error of shot (yedinichnyy ellips oshibok vystrela) ($\underline{V}b_p$ or $\underline{V}d_p$) to the greater, designated $\underline{V}_p$. This graph is given in (15) and is used in the curriculum of the Higher Artillery Academy and among the troops. It

* E defines the convexity (as opposed to the/one word missing/) of the ellipse.
With E = 1 when /10 words missing/.

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allows Q and P to be determined comparatively simply, but only when the point of aim coincides /?/ with the target. In practice, besides this method, there is also used the method of resolving these problems in accordance with the formula:

$$R_p = k\gamma \, /?/ \; d \qquad (13)$$

- k = coefficient /one word missing/ with probability of destruction of target P;
- γ = mean circular error of shot (sredinnaya krugovaya oshibka vystrela);
- d = the distance between the point of aim and the center of the target.

Using this formula it is possible to determine R_p and, consequently, Q, even when the point of aim is at a certain distance d from the center of the target. To do this it is necessary to give the appropriate value to the coefficient k in the formula; this value is found from the auxiliary graph $k = f(P, d, \gamma)$. When d is known, in some cases when the elliptical error of shot is near to the circular one, and is defined by the magnitude E within the limits of 0.5 to 1.0, then by using formula (13) and the graph $k = f(P, d, \gamma)$ it is also possible to find the approximate value of P, the probability of destruction of the target.

The fact is that it is unusual to determine the mean circular error of shot γ, from the following circumstance; that the probability of destruction of the target calculated by using γ must be /one word missing/ equal to the probability of destruction of the target calculated by using the actual elliptical error of shot, characterized by V_p and E. The established circular error γ found in this manner depends on P, E and V_p because $\gamma = f(P, E, V_p)$. In cases where E = 0.5 ∓ ?, γ only negligibly depends on P and therefore it becomes possible, particularly by using the formula

$$\gamma \; ? = \sqrt{Vb_p \, /?/ \underset{?}{+} Vd_p /?/}$$

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to find the approximate circular error of shot $\psi_?$ which with certain tolerance /?/ may be considered independent of P. In these circumstances the solution of problems by using $\psi_?$ is accompanied by /?/ permissible errors.

When E is less /?/ than 0.5, ψ will substantially depend on P, and therefore the determination of probability of destruction of target P by using the circular error ψ which itself depends on this probability, is not possible, and the solution of this problem using the approximate circular error may lead to inadmissible errors. *

Considering the circumstance that over a wide compass of ranges of fire with tactical missiles, E is less than 0.5, this work sets out a fairly accurate method of solving problems of determining Q and P for any value of d by using the elliptical error of shot with the characteristics E and V_p.

Using the proposed method, it is recommended that Q and P should be found from the expression:

$$R_p = \eta V_p \qquad (14)$$

when $\eta = f$ (P, d, E) - the coefficient allowing for the probability of a hit and a circle of radius R_p depending on E and the displacement d of the center of dispersion in relation to the center of the circle.

The values of the coefficient η for various values of d, P, and E are given in a table in the appendix. Also in the appendix are graphs for $\eta = f$(P, d, E) constructed on the basis of the table where E = 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2 and 0.1, i.e., for the whole of the practical possible range of values of E.

The solution of problems of launching nuclear strikes against individual targets, using the graphs given in the

* The problem of circular error of shot is described in detail in (18).

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appendix, are shown in the following examples.

Example 1.

Determine the required (minimum) yield of a nuclear charge Q for the destruction of a battery of 203.2mm guns in firing positions, with a probability of 90 percent, when using a tactical missile at the range of 18km($\underline{V}_p$ = 320 meters, E = 0.35), air burst, the point of aim is displaced in relation to the target d = 500 .

Solution. 1. $\frac{d}{\underline{V}_p} = \frac{500}{320} = 1.56$

2. in the appendix we find the graph for E = 0.4 * using this and with d = 1.56 and P = 90 percent we find the value for coefficient Λ= 3.4

3. $R_p = \Lambda \underline{V}_p$= 3.4 x 320 = 1090m, Q= 88kt.

Example 2.

Determine the probability of destruction of a 280mm gun at a firing position, 800mfrom a target against which a nuclear strike is being delivered with a tactical missile with a nuclear warhead of 5kt yield, air burst, range 22km ($\underline{V}_p$ = 280m, E = 0.5).

Solution. 1. $\frac{d}{\underline{V}_p} = \frac{800}{280} = 2.86$

2. using Q = 5kt we find the radius of destruction of the gun R_p = 1220m/?/ /one word missing/ it and V_p, we determine $\Lambda = \frac{R_p/?/}{\underline{V}_p/?/}$= 4.35 /?/

* The values of E are given to the nearest decimal point, reducing the value when the hundredths /?/ are less than 5 and increasing it when the hundredths are 5 or over. The error in values of Q and P resulting from this are negligible.

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3. in the appendix we find the graph for $E = 0.5$, with the aid of which, with $\bar{d} = 2.86$ and $\eta = 4.35$ /?/ we find $P = 90$ percent /?/

The proposed graphs may also be used for the solution of problems when performing the tasks of firing against a group target. *

As noted earlier, the area covered by a group target, representing a great many elementary targets or several individual targets of equal vulnerability, dispersed arbitrarily, can always be represented by a minimal area of a circle with radius R_{ts}, within which lie all the targets subject to destruction. It is assumed that any one individual (elementary) target may be located on the edge of the area and will be $d' = R_{ts}$ distant from the center of the circle, which is also the point of aim. With the aid of the appropriate graph (see appendix) we can then find $R_{ts} = \eta V_p$ /?/ and consequently, also Q, ensuring the destruction of each of the individual targets farthest removed from the point of aim, with probability $P = 90$ percent, or the probability of destroying each of these targets when using a nuclear charge of a given yield Q.

Should the point of aim for some reason be displaced in relation to the center of the circle by a value d, then the solution of problems in determining Q or P is found by using $\eta = R_{ts} + d$ /?/.

The method of working out of problems in connection with the destruction of group targets is shown in the examples below.

Example 3

To determine the yield of a nuclear charge for the destruction with a probability of 90 percent /?/ of an army ammunition supply point deployed on an area of 4 /?/km^2.

* Graphs may be used also in determining /three words missing/ of center of the burst from the center of the target (V_p) /one line missing/ and the required probability P.

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(R_{ts} = 1130m/?/), using an operational-tactical missile at a range of 170km (V_p = 810m, E = /0.49?/), air burst, point of aim is the center of the area.

Solution. 1. We get $d^1 = \frac{R_{ts}}{V_p} = \frac{1130}{810} = 1.4$

2. in the appendix we find the graph for $E = 0.5$, with the aid of which, with $d^1 = 1.4$ and P = 90 percent we find $\eta = 3.35$.

3. using the known values for η and V_p, we resolve $R_p = \eta \times V_p = 3.35 \times 810 = 2710$ from which, according to the graph (Figure 9) Q = 69kt.

Example 4

A 100kt missile strike is delivered against two "Corporal" guided missile launchers on launch sites, 2km apart (the location of the guidance post is not known), air burst, point of aim halfway between the launchers, range 150km (V_p = 730m, E = 0.53).

To be determined: (a) the probability of destruction of each of the two launchers,

(b) the distance from the point of aim, inside which the guidance post will be put out of action with a probability of not less than 90 percent;

(c) the probability of destruction of the guidance post if it is known that it is located not more than 2800/?/m from the point of aim.

Solution 1. Using the graph (Figure 9) from Q = 100kt, determine the radius of destruction for a "Corporal" launcher at launch site R_{p1} = 3080m, and for the guidance post R_{p2} = 2,800/?/m.

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(a) Considering each launcher as a separate target at a distance, d, of 1000m (for 1.27 /?/ V_p) from the point of aim, /one word missing/ R_{p1} and $\underline{V_p}$, we find

$$\eta = \frac{R_{p1}}{\underline{V_p}} = 4.2$$ and with aid of a graph for

E = 0.5, η = 4.2 and d = 1.27 we find $\overline{P}$= 97 percent.

Therefore each of the launchers will be destroyed.

(b) Expressing R_{p2} in terms of $\underline{V_p}$ we find

$$\eta = \frac{R_{p2}}{\underline{V_p}} = 4$$

From the graph for E = 0.5, if η = 4 and P = 90 percent we find d = 2.2 $\underline{V_p}$ = 1600m.

Thus, if the guidance post is located at a distance of up to 1600m from the point of aim, it will be destroyed.

(c) Expressing R_{p2} in terms of $\underline{V_p}$ we find η = 4; if η = 4 and $d = \frac{2800}{730} = 3.85$, by using the graph for E = 0.5 we determine P = 50 percent, i.e., if the guidance post is located at the maximum possible distance from the point of aim the probability of its destruction will be 50 percent.

As can be seen, the solution of these problems by using graphs is fairly simple and, what is most important, is done with the use of the actual elliptical errors of shot, i.e., the necessity of substituting the circular error for the elliptical error of shot is eliminated. Some inconvenience is caused by the large number of graphs, but it is fully justified by the great accuracy of the result obtained. Simpler approximate methods of solving these problems by means of graphs or based on graphs may be developed in the future.

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When planning nuclear strikes it is more convenient to use tables compiled beforehand showing the yield required for the destruction of individual and group targets, rather than calculations. It should be noted that, depending on circumstances, the distances between the elements of the battle formation of a certain subunit, representing a group target or, what is the same, the area of the group target may vary over a considerable amount (this can be seen from Table 22). In this connection, in the table for group targets Q should be [one word missing] depending on the size of the area of the group target. By interpolating between the values in the tables the required Q may be found.

Tables of this kind are given below.

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Table 23

The required yield Q of a nuclear charge for the destruction of an individual target using tactical missiles 3R10 (air burst, point of aim coincides with target).

No.	Designation of target	Q(kt) at a range of D(km)						
		Fuse Mechanism VDM-T		Fuse Mechanism 3917				
		12	16	16	20	24	28	32
1	2	3	4	5	6	7	8	9
1	"Lacrosse" guided missile, "Honest John" and "Little John" free rockets, 280mm gun at firing position	1	1	1	1	1	1	1
2	"Lacrosse" guided missile, "Honest John" and "Little John free rockets in a waiting position and on the march Transport with "Lacrosse", "Honest John" and "Little John" missiles/rockets							

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Table 22 continued

	Designation of target	Q (kt) at a range of D (kms)						
		Fuse Mechanism VDM-T		Fuse Mechanism 3917				
1	2	3	4	5	6	7	8	9
	Ammunition storage installation for "Lacrosse", "Honest John" and "Little John" subunits	1	1	12	8	7	7	11
3	Battery of 203.2 mm guns at firing positions, 280mm gun in a waiting position and on the march	6	7	42	28	24	25	39/?/
4	Technical position of "Lacrosse" guided missile, "Honest John" and "Little John" free rockets, and 280mm gun subunits	1	1	5	3	3	3	5/?/

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Table 24

The required yields Q of nuclear charge to destroy an individual target by firing 8K11 missiles (izdeliye) (air burst, point of aim coincides with target).

No.	Designation of targets	Q (kt) at a range of D(km)						
		60	80	100	120	140	160	180
1	2	3	4	5	6	7	8	9
1	"Corporal", "Sergeant", and "Redstone" guided missiles at launch site	4	6	10	14	19	27	39/?/
2	"Corporal", "Sergeant", and "Redstone" guided missiles on the march Transport with "Corporal", "Sergeant", and "Redstone" missiles Ammunition storage installations of "Corporal", "Sergeant", and "Redstone" guided missile subunits	37	52/?/	7?	100	150	200	250

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Table 24 continued

	Designation of targets	Q (kt) at a range of D(km)						
1	2	3	4	5	6	7	8	9
3	"Matador" ("Mace") cruise missile at launch site Technical position of subunits of "Corporal" "Sergeant" and "Redstone"guid-ed missiles	13/?/	17	24/?/	32/?/	45	59/?/	76
4	Guidance post for guided missiles, position of radar station controlling cruise missiles	8	10	15	20	28	37	48

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Table 25

The required yields Q of nuclear charge to destroy a group target using tactical missiles 3R10 (air burst, most effective point of aim).

Serial	Designation of targets	Size of target		Q (kt) at a range of D(km)						
		R_{ts} (m)	S_{ts} (km^2)	Fuse Mechanism VDM-T		Fuse Mechanism 3917				
				12	16	16	20	24	28	32
1	2	3	4	5	6	7	8	9	10	11
1	Subunit of "Lacrosse" guided missiles, "Honest John" and "Little John" free rockets or 280mm guns at firing positions	200	0.1	1	1	1	1	1	1	3
		400	0.?	1	1	3	1	1	1	3
		600/?/	1.0	1	1	5	3	?	4	5
		800	2.	3	3	9	7	7	7	9
		1200	4	10	10	19/?/	15/?/	15	15/?/	18
		1600	8 /?/	22	22	25/?/	30	30	30/?/	23/?/
		2000	12	27	28/?/	??	?2	??2	32/?/	?7
		2400	19	63/?/	65/?/	80/?/	??	??	81/?/	88/?/

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1	2	3	4	5	6	7	8	9	10	11
2	Battalion of 203.2mm guns in siting area (at fire position)	600	1	46	46	130	90	90	95	120
		800	2	85	85	200	160	150	155	190
		1200	4	220	220	375	325	320	315	370
	Battalion of 280mm guns or 203.2mm guns in concentration area (waiting area) *	1600	8	450	450					
		200 /sic/	12			More than 500				
3	Subunits of "Lacrosse" guided missiles, "Honest John", "Little John" free rockets in concentration area *	600	1	18	18	33	23	23	24	30
		800	2	22	22	50	40	38	39	48
		1200	4	57	57	100	86	85	85	97
		1600	8	120	120	190	120	120	120	190
		2000	12	210	210	310	275	275	275	300

/Half page missing. This presumably contains the remainder of Table 25 and the heading and beginning of Table 26/

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Table 26

	2	3	4	5	6	7	8	9	10	11
		1600	8	47	53	62	72	85	95	115
		2000	12	76	83	90	100	125	140	160
		2400	18	115	125	140	155	175	195	220
	Subunits of "Matador" ("Mace") cruise missiles in siting area (on launch pads)	200	0.1	15	19	27	35	50	62	84
		400	0.5	19	25	33	41	56	71	93
		600	1.0	25	32	40	50	66	81	105
		800	2.0	34	44	52	68	82	100	120
	Subunits of "Nike-Hercules" antiaircraft guided missiles in the siting area (at launch pads)	200	0.1	34	42	64	83	120	160	210
		400	0.5	41	58	77	96	140	180	2?0
		600	1	60	75	95	120	165	205	265
		800	2	80	100	125	175	210	250	300
		1200	4	150	175	215	245	300	350	420
	Subunits of "Corporal" "Sergeant", and "Redstone" guided missiles in concentration area*	600	1	80/?/	96	130?	150	220	265	335
		900	2	100	140	170	225	270	315	380
		1200	4	200	230?	275	310	380	450	
		1600	8	320?	360?	410	475			
		2000	12			More than 500				
		2400	16							

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As can be seen from Tables 25 and 26, the destruction of guided missile, free rocket, and artillery subunits deployed in a concentration area (marked with an asterisk) requires nuclear charges with considerable yield. These have been worked out on the assumption that shelters for personnel have been provided in the concentration areas. If it is known for sure that no shelters for personnel have been provided in the concentration areas, then the yields of nuclear warheads to destroy subunits deployed in concentration areas will be the same as the yields necessary to destroy these subunits if they were deployed in the siting area (see Serial 1, Tables 25 and 26).

When the yields of the nuclear charges for each delivery system which are being released for the operation are known beforehand, it is advisable to compile tables similar in form to the tables given, but showing the probability of destruction of the target by each of the allotted nuclear charges instead of Q.

4. The selection of type and height of a nuclear burst.

With a nuclear burst the destruction caused at the moment of the burst is the result of the impact on targets located near the burst, of shockwave, thermal radiation, and penetrating radiation, and that following the burst is the result of radioactive irradiation (oblucheniye) (contamination) of various targets in the path of the radioactive cloud.

The destructive effect of a nuclear burst on targets located near the burst is defined by the radius of the destruction zone, R_p. The radius of the destruction zone of a certain target depends chiefly on the yield of the nuclear burst. As for the effect of the height of the nuclear burst on a change in magnitude of the destruction radius, it is insignificant. That is why handbooks on nuclear weapons give values for R_p only for air (within the limits of low to very high) and ground nuclear bursts. And, as shown in one of the previous paragraphs, R_p for a ground and an air burst varies only 3 to 20 percent in

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magnitude, depending on the nature of the targets.

The selection of a certain type and height of nuclear burst is dictated chiefly not by the desire to obtain a greater radius of the destruction zone, but by the necessity to obtain a certain radioactive contamination of the ground, and this contamination changes considerably with the height of burst. It is just for this reason that nuclear bursts are subdivided according to altitude into ground, low air, high air, and very high air bursts. The average necessary height of a low H'_n /?/, high H'_v /?/, and very high H'_{ov} /?/ air burst is determined by the well-known formulae:

$$H'_n \text{ /?/ } = 7\sqrt{Q} \qquad H'_v \text{ /?/ } = 12\sqrt{Q} \qquad H'_{ov} \text{ /?/ } = 17\sqrt{Q} \quad (15)$$

/NOTE: These roots may not be square. The original is too indistinct to tell/

The level of radioactive contamination of terrain, and consequently the destructive effect after a nuclear burst, increases as the height of burst is reduced/?/. The maximum effect /two words missing/ after /?/ a nuclear explosion is achieved with a ground /?/ burst.

It should be noted that if all the favorable conditions of the situation are calculated correctly, a ground nuclear burst will have a more considerable total destructive effect on a target than an air nuclear burst because of radioactive contamination. The advisable conditions for the selection of certain height of an air nuclear burst are specified in detail in the appropriate Regulations and basically correspond to the requirements for delivering nuclear strikes against enemy offensive nuclear weapons, and so we shall not pursue this question here. As for ground bursts, when the situation and meteorological conditions permit, it is advisable to use them for the destruction of:

--army ammunition supply points;

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--firing positions (launch sites, waiting areas, and technical positions) calculated so that some will be destroyed by the nuclear burst and others by the radioactive fallout in the path of the radioactive cloud;

--enemy offensive nuclear weapons on the march when they are passing through defiles, large forest areas, water crossings, etc;

--enemy offensive nuclear weapons located in concentration areas and in anticipated /?/ areas.

In practice, during the selection of the type and height of a nuclear burst, it is essential to take into consideration the forthcoming actions of friendly troops to determine the type of burst, and then to determine the tabular height (tablichnaya vysota) depending on the type of burst and the yield of the nuclear charge /?/.

The tabular height of a ground burst is taken to equal zero.

The tabular height of a nuclear air burst should be calculated making allowance for the dispersion of the burst in height (rasseivaniye vzryva po vysote).

Using tactical missiles with VDMT fuse mechanism at a range of 10 to 16 km, the magnitude of mean deviation (otkloneniye) in height of a burst ($\underline{V_{r\,vp}}$) is on the average equal to 80m.

With such a considerable dispersion of the burst in height, there is a great probability of getting a low air burst when the necessary height has been selected so as to get a high air burst. In just the same way the probability of obtaining a surface burst, when the necessary height has been selected so as to get a low air burst is inadmissibly /?/ high.

The formula for determining the tabular height is:

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$$H_{?} = H'_{?} + \eta' Vrv_{p} \qquad (16)$$

when $H'_{?}$ = the necessary height of air burst, determined in accordance with formula (15);

Vrv_{p} = mean deviation in height of burst;

η' = coefficient to allow for the probability of a burst at a height not less /?/ than the necessary height.

The coefficient η' is assumed to equal 2 for low air bursts and 1 for high and very high air bursts. The probability of getting an air burst at a height not less /?/ than the necessary height will equal 91 percent for low air bursts and ??percent for high and very high air bursts.

Tabular heights of bursts, calculated in accordance with formula (16) for firing tactical missiles with fuse mechanism VDMT, at a range of 10 to 16 km are given in Table 27.

Table 27

Tabular height of an air burst, firing tactical missiles 3R10, with VDMT fuse mechanism.

Type of burst / Q (kt)	10	20	30	50	100
Low air burst	310	350	380	420	480
High air	340	410	450	500	640
Very high air	450	540	610	710	860

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For missiles with proximity fuses (radiovzryvatel) Vr_p does not exceed 10m. When the dispersion in height is so insignificant, the tabular height of a nuclear burst is practically the same as the necessary height. Therefore when firing missiles with proximity fuses, the tabular height of the nuclear burst is calculated in accordance with formula (15).

5. Determination of the most effective location for the point of aim.

The most effective location for the point of aim will be taken to be that point at which the targets (target) intended for destruction are destroyed by a nuclear charge of minimum yield.

The location of the point of aim determined for a minimum yield nuclear charge will obviously also be correct for a nuclear charge of greater yield.

In each case where a nuclear charge is used, there is an optimum location for the point of aim, and this depends chiefly on the nature, location (relative distance), and dimensions of the targets to be destroyed, their resistance to the effects of the nuclear burst (relative vulnerability), the probability of destruction, and the accuracy of the delivery system.

Before proceeding to the solution of the problem of determining the most effective location for the point of aim, let us consider the idea of the vulnerability of the target. It is known that for a given Q the radii of destruction zones for targets of different nature vary in magnitude, i.e., if, for example, for target A the radius of the destruction zone corresponds to the magnitude R_{p_A} /?/ and for target B, R_{p_B} /?/, then R_{p_A} /?/ $\neq$ R_{p_B} /?/. Comparison between radii of destruction zones for these targets for different values of Q shows that the ratio $\frac{R_{p_A} /?/}{R_{p_B} /?/}$ remains

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approximately constant for all values of Q.

Let us call the vulnerability of a given target A coefficient ξ equal to the ratio of the radius of destruction zone of this target at a certain value of Q to the radius of destruction zone of personnel in the open at the same value for Q, i.e. $\xi_{?} = \frac{R_{p_{A/?/}}}{R_{p???}}$. The values for the coefficient ξ determining the vulnerability of the targets studied above are given in Table 28.

Table 28

Values of coefficient ξ	
Nature of target	ξ
1	2
Personnel in the open	1
Radar station of the SON-4 type	0.9
Motor vehicles, "Matador" cruise missiles	0.75
"Honest John" free rocket	0.57
"Corporal" guided missile	0.52
Guns of field artillery	0.37
Personnel in shelters	0.25

The relative vulnerability of two targets of different nature will be determined by the ratio of the corresponding coefficients (the lesser to the greater).

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We shall consider the most common of the possible cases of determining the most effective location for the point of aim when a nuclear strike is delivered to destroy individual or group targets of different vulnerability. The conclusions so obtained may be extended to other cases as well.

The conditions of the problem of determining the most effective location for the point of aim will be formulated in the following way.

We have two individual targets, located at a distance C from each other; target A, the vulnerability of which is represented by value ξ_A /?/ and target B, the vulnerability of which is represented by the value ξ_B /?/, and ξ_B /?/ $<$ ξ_A /?/.

The problem is to determine the location of the point of aim from which each target will be destroyed by a nuclear weapon of minimum /?/ yield Q with probability of destruction P = 90 percent.

Evidently the /one word missing/ point of aim must lie on the straight line connecting A and B, at a certain distance $d_?$ from the less /?/ vulnerable target B and a distance $C-d_?$ from target A.

The solution of the problem, in fact, amounts to determining d? at which each of the targets will be destroyed with a probability P = 90 percent. This problem may be solved with the aid of the graphs given in the appendix.

Because it is possible to fire at any value for E, it is necessary to trace the relation of η to E when P = 90 percent is a constant. This relationship is shown in Figure 10. Figure 10 shows that if P = 90 percent, $\eta = f(d,E)$ changes in relation to E only insignificantly, so that with a certain degree of error, E may be taken to be a constant, equal to its average value which is

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$\underline{E}_{\underline{sr}} = 0.8$.

So, the problem of determining the most effective location for the point of aim may be solved with the aid of the graph $\eta = f(d,P)$ when $\underline{E} = 0.8$. To do this it is necessary, using the given values C and $\xi_?$ and setting various η, to determine with the aid of the selection graph (grafik podbora) the minimum d? at which each target will be destroyed with a probability P = 90 percent.

On the basis of the solution of the problem using different values for C and ξ a graph was constructed (Figure 11) to determine the distance d of the point of aim from the less vulnerable target.

On the graph (Figure 11), along the horizontal axis are shown the distances between the targets C, expressed in terms of V_p and along the vertical axis the distance d? of the point of aim from the less vulnerable target. In terms of C, the line of the graph is plotted through the points which are characterized by equal relative vulnerability.

The method of determining the most effective location for the point of aim with the aid of the graph in Figure 11 is illustrated in the following example.

Example 6

To determine the most effective location for the point of aim in order to destroy with one nuclear charge an "Honest John" free rocket launcher in a waiting position and a battery of 203.2mm guns located 1km from each other, when using a tactical missile at 28km range ($\underline{V_p}$ = 260m).

Solution: 1. from data in Table 28 we determine

$$\xi = \frac{\xi_{203\,/?/}}{\xi_{\infty\,/?/}} = \frac{0.37}{0.57} = 0.65.$$

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2. we express C in terms of $\underline{V_p}$ ($C = \frac{1000}{260} = 3.85$)

3. from the graph with $\xi = 0.65$ and $C = 3.85$ by interpolation we find $\frac{d^?}{C} = 0.23$, from which $d^? = 230$m.

Therefore, the point of aim is located on the straight line joining the targets under consideration, 230m from the battery of 203.2mm guns.

The graph (Figure 11) may also be used to determine the most effective location of the point of aim when launching a nuclear strike against two group targets. In this case C should represent the distance between the two most distant points in the particular group targets.

<u>Example 7</u>

Two group targets: $\underline{Ts}$ 1 with $R_{\underline{ts}}1 = 500$m and $\xi_1 = 0.8$

$\underline{Ts}$ 2 with $R_{\underline{ts}}2 = 1000$m and $\xi 2 = 0.6$

Distance between centers of targets - $C^2 = 2000$m.

Determine the most effective location for point of aim when $\underline{V_p} = 400$m.

Solution. 1. we determine $\xi = \frac{\xi_2}{\xi_1} = \frac{0.6}{0.8} = 0.75$

2. we determine $C = R_{\underline{ts}}1 + C2 + R_{\underline{ts}}2 =$

$500 + 2000 + 1000 =$

$3500 = 8.75\ \underline{V_p}$

3. from the graph with $\xi = 0.75$ and $C =$

$8.75\ \underline{V_p}$ we find $\frac{d^?}{C} = 0.39$ therefore

$d^? = 0{,}39\ C = 1370$m.

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That is, the most effective location for the point of aim is on the straight line joining the centers of the targets 1370m from the center of target No.2.

Employment of the above method of determining the most effective location of the point of aim for fire at various targets permits the formulation of the following practical recommendations:

When delivering a nuclear strike against an individual target the point of aim should coincide with the target.

When delivering a nuclear strike against a group target consisting of several individual targets of equal vulnerability or of a large number of elementary targets of equal vulnerability dispersed at random over a certain area and also when delivering a nuclear strike against two or more group targets of equal vulnerability, the point of aim should be the center of the smallest circle whose circumference will contain all the targets earmarked for destruction.

When delivering a nuclear strike against a group target consisting of two individual or group targets of unequal vulnerability, the point of aim should be selected by using the graph (Figure 11).

Chapter Conclusions

1. To destroy enemy offensive nuclear weapons, tactical and operational-tactical missiles with nuclear warheads should be used.

2. Using tactical missiles 3R10 at the most effective range, a nuclear charge with a yield of up to 10kt will be required to destroy individual guns and launchers at a firing position (waiting position) and on the march, and to destroy a battery of "Lacrosse" guided missiles, a battery of 280mm guns, or a battalion of "Honest John" ("Little John") free rockets deployed in the firing position; but a nuclear charge with a yield

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of up to 24kt will be required to destroy a battery of 203.2mm guns at a firing position, and a nuclear charge with a yield of more than 100kt will be required to destroy offensive nuclear weapons in concentration areas provided with shelters for personnel.

3. Using an 8K11 missile (izdeliye) to destroy the more typical targets, the following yields of nuclear charges will be required, depending on the range:

from 4 to 50kt - to destroy an individual guided missile at the launch site or a guidance post for guided missiles (cruise missiles).

from 10 to 80kt - to destroy a "Corporal", "Sergeant", or "Redstone" guided missile battalion; a detachment (otryad) of "Matador" ("Mace"), cruise missiles, and an army ammunition supply point. The destruction of enemy offensive nuclear weapons in concentration areas will require a nuclear charge of over 500kt.

4. The effectiveness of using missiles with nuclear warheads depends largely on the correct selection of the point of aim. When delivering a nuclear strike against a group of targets of similar vulnerability the point of aim should be the center of the smallest circle whose circumference will contain all the targets earmarked for destruction. When delivering a nuclear strike against a group target consisting of two individual or group targets of unequal vulnerability, the point of aim should be selected by using the graph (Figure 11).

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Radii of Destruction Zone

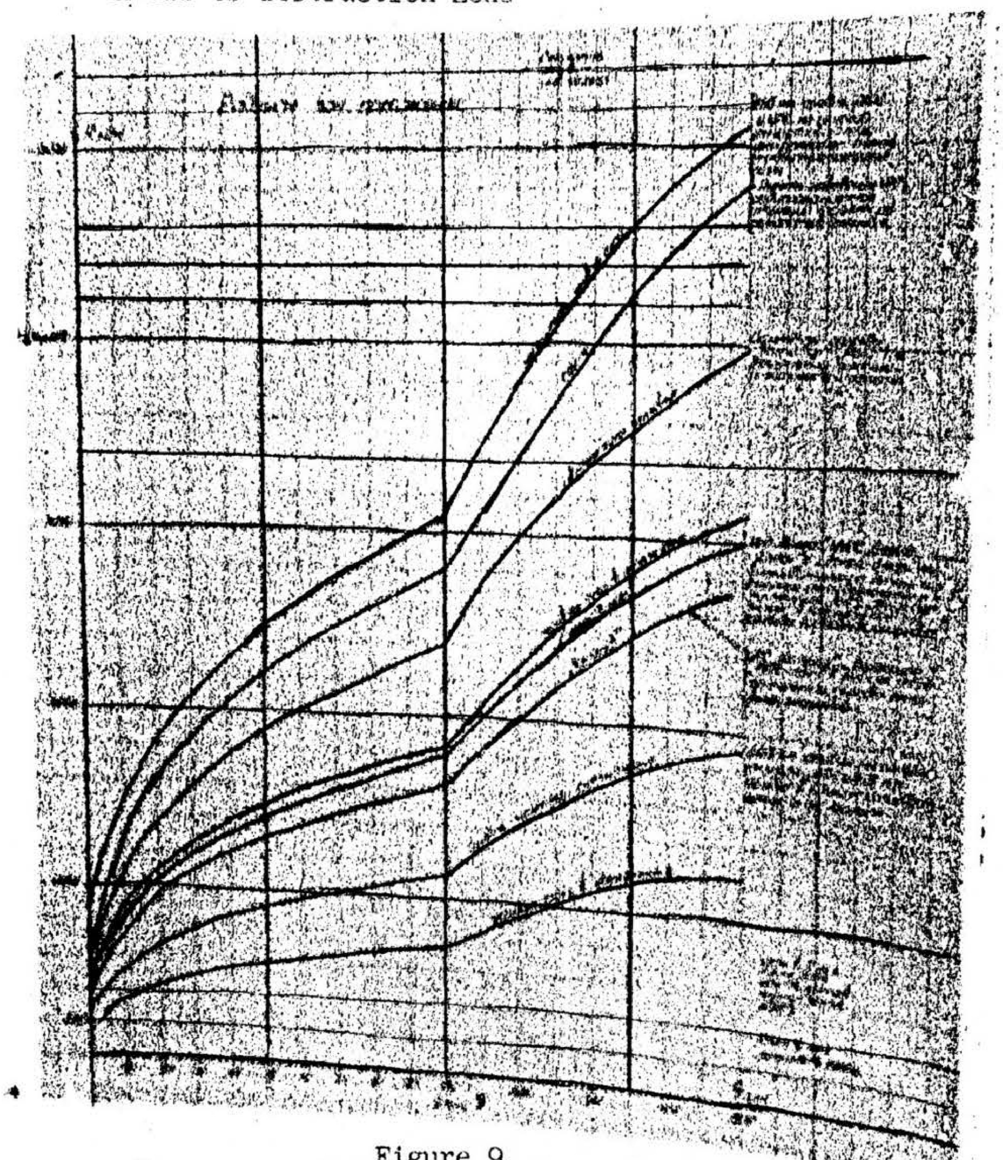

Figure 9
/Note: Writing illegible but see Chapter IV, para 1?/
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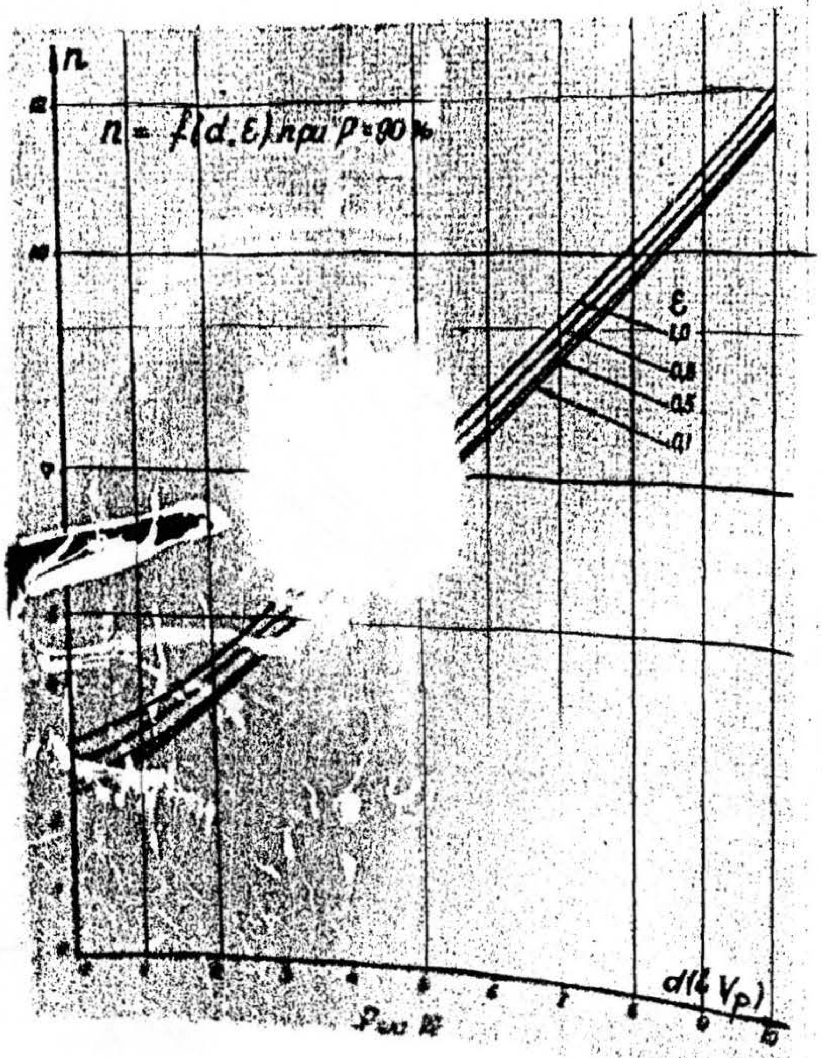

Figure 10

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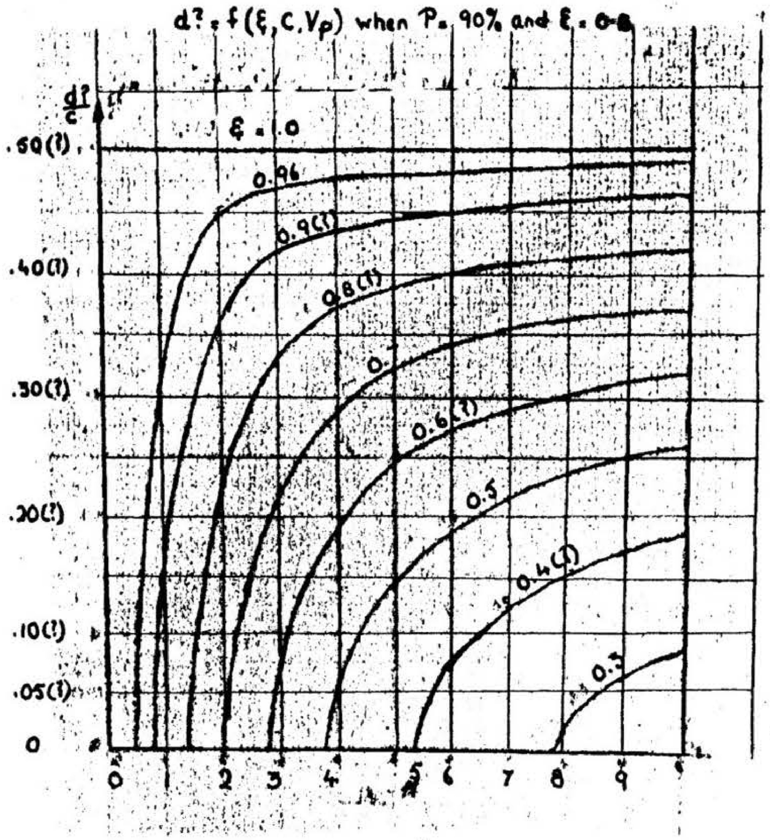

Figure 11.

[Note: For explanation, see Chapter IV, paras. 66-67)

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